Standard Operating Procedure

Turbidity by Nephelometer

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Approved By: *Courtney Diduck*, Analytical Services Branch Head

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N:\Environmental Standards\Analytical Services\SOP (PDFs)

Hyperlinks to external documents and navigation within this document are highlighted and underlined in green font. These links are functional in the electronic version of this document, when the user has permission and the document is viewed within the City of Winnipeg's intranet site from the above mentioned folder. All documents pertaining to this SOP are maintained in subfolders of the following Master Folder; N:\Environmental Standards \Methods\Turbidity (SOP 15)

Latest revisions are highlighted in blue print.

All hand-written amendments (except for spelling or grammatical errors) must be approved immediately by the Analytical Services Branch Head or Quality Assurance Officer, who shall initial and date the amendments. The procedure shall be formally revised and reissued as soon as practicable.

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All forms, reagent logs are located in; TurbidityForms.xlsx[1]

Control Charts are printed from; ChartGenerator.xlsm[2]

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Introduction and Scope

Turbidity is a measure of an optical property that causes light in an aqueous sample to be absorbed and scattered by minute particles rather than transmitted. The higher the intensity of scattered light, the higher the turbidity.

Suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, and plankton and other microscopic organisms cause turbidity in water. The turbidity caused by suspended particles is a measure of the clarity of water. Since a change in turbidity reflects a change in water quality, this is a simple but very important analysis used in water and wastewater monitoring with laboratory or on-line instruments.

A Nephelometer is defined as a turbidity instrument capable of measuring the scattered light at 90° and reported as NTU. A Nephelometer consists of a light source, a lens aperture and a photoelectric detector at 90° from the transmitted light. Very low turbidity exhibits very little change in the direct measurement of transmitted light but is much more sensitive at the 90° angle. Higher concentrations also cause multiple scattering interference with direct light, thus making the 90° a more accurate measurement. Some instruments (Hach 2100N) also include a forward-scatter light detector, transmitted light detector and a back-scatter light detector. If the "Ratio On" mode is used then the instrument uses a mathematical calculation to "ratio" the signal from the four detectors.

Formazin is the only primary standard recognized and approved for calibration of any turbidity instrument ratio or non-ratio. Formazin can be reproducibly prepared from assayed raw materials and the physical characteristics make it a desirable light-scatter calibration standard. The Formazin polymer consists of chains of several different lengths, which fold into random configurations. This results in a wide array of particle sizes and shapes that are found in real samples. This randomness yields statistically reproducible scatter on all makes and models of turbidimeters. Secondary standards can consist of either Formazin or suspensions of micro spheres of styrene divinylbenzene copolymer.

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Scope

This method pertains to the measurement of Turbidity in water and wastewater when measurements are conducted in the laboratory.

Referenced Method

This method is modified from Standard Method for the Examination of Water and Wastewater[3], Approved by Standard Methods Committee, 1997, Editorial Revisions 2011, 2130A Turbidity & 2130 B Nephelometric Method. The method contains the following modifications;

i. The instrument measures at three angles (three ratios) which it then averages.

ii. The laboratory purchases all of the Primary and Secondary Standards.

iii. Samples over 40 NTU are diluted in range with laboratory reagent grade water.

iv. Samples are normally not degassed, unless the air bubbles are visible.

v. The meter located in the Analytical Services Branch, WQ section is attached to an air source to prevent condensation of the Turbidity Cells. The latter occurs during summer months only.

Applicable (Instrument) Range

The applicable range is 0.05 to 10,000 NTU but samples greater than 40 NTU must be diluted. The higher range is only used to estimate the dilution required.

Working (measurement) Range

The working range is 0.05 to 40 NTU. This is the only true linear range in a Nephelometer. Samples greater than 40 NTU are diluted within this working range and calculated.

Detection Limit

The Minimum Detection Limit based on 3 standard deviations of repeated measurements of a low level standard is 0.05 NTU.

Note: Even water molecules will scatter light, therefore pure distilled or DI water cannot have a zero turbidity reading and a Turbidity Meter cannot be set to zero.

Accuracy

Bias

The bias based on a Certified Reference Material used in every batch, (as relative bias) is 0.995 and is thus not used in any calculated result.

Precision

The precision, calculated as two times the Relative Standard Deviation from duplicates included in each batch is 0.024 (ASB) and 0.060 (WTP).

Uncertainty

The uncertainty of the method based on the combined uncertainty of the Duplicates and Certified Reference Material is 0.031 (ASB) and 0.063 (WTP).

$U_{combined} = U_{dupl} + U_{crm}$ or $RSD_{comb} = RSD_{dupl} + RSD_{crm}$

Fit-for-use

This method is fit for its intended use for the determination of Turbidity in water and wastewater and other aqueous solutions in the applicable range of 0.05 to 10,000 NTU.

Method Validation[4] By: Gerry Levesque, Quality Assurance Officer, August 5, 2011 and last updated on October 29, 2014.

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Summary of Method

The Nephelometer or ratio turbidimeter is routinely calibrated against Formazin polymer primary standards. Secondary standards, which are then standardized against the primary standard, are used in the daily use of the instrument. The sample(s) is then measured under the same operating conditions and a direct readout is obtained. Special handling and the use of silicone oil on the glass sample cells minimize interferences. Air bubbles must also be removed or minimized by one of several techniques. Samples greater than 40 NTU are diluted to fall within the 0 to 40 NTU range, the only true linear range of any ratio turbidity meters. The higher range is only used to determine or estimate the dilution required.

Readings can be obtained with Manual or Automatic Range selection and with signal averaging on or off. With Signal Averaging On, ten readings are taken and the average is displayed. Under normal operating conditions, Automatic Range Selection with Signal Averaging and Ratio On is used.

A USEPA filter is also used for all aqueous sample matrices.

LIMS Test Codes and Definitions

Turbidity Turbidity by Nephelometer

DI as in "DI water" is the water produced by reverse osmosis and ion exchange system. At the ASB laboratory, this water which meets the laboratory reagent grade water and when further polished is referred to as **MilliQ™** water or **WaterPro** water at the WTP laboratory.

Sample Requirements

Sample History

Field or Laboratory Filtration

Not applicable.

Containers

Plastic or glass containers are suitable for sample collection.

Volume Required

A minimum of 100 mL of sample is collected.

Sample Collection

All samples are collected by personnel specifically assigned to those duties as described in SOP-17 Sampling[5], SWI-17-05 No Head Space (sampling procedure).

Preservation

Analyze samples as soon as possible but if this is not practical, preserve by refrigerating at 4 ±2°C to minimize microbiological decomposition of solids. If temperature has an effect on the solubility of the sample then analyze immediately. Samples can be left at room temperature when analysis is to be done within 2 hrs. Do not refrigerate if sample is to be analyzed within a few hours. This can sometimes alter the composition by introducing more precipitated matter.

Store all standards at room temperature.

Holding Time

Refrigerated samples can be held for 48 hours.

Sample Pretreatment

Gently agitate all samples before examination to ensure a representative measurement. Do not alter the pH or other sample conditions.

Dilute quantitatively very turbid or highly coloured samples before measuring. All samples greater than 40 NTU must be diluted with DI water.

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Taking Aliquots

24 Hour composite wastewater effluent samples are initially collected in large plastic containers (16L or 20L) which are then transported back to the laboratory. Taking aliquots from those containers is not possible, therefore a representative portion is poured into 2L beakers to reduce the volume down to 1 ½ to 2 L. This portion is considered as the original sample. For turbidity analysis, fill a plastic sample cup about 2/3 full from the 2L beaker, following the procedure "Sample Aliquots" in SOP 17, Sampling. Ensure that the cups are uniquely identified. Duplicates are also taken from these containers.

Interferences

Air bubbles can create a positive interference. Remove air bubbles by degassing, vacuum or ultrasonic bath as outlined in the instrument manual, Model 2100N Laboratory Turbidimeter.

Scratches, finger marks, or dirt on the walls of the sample cell may give erroneous readings. Use silicone oil and cloth to minimize interferences as outlined in the Test Procedure: Oiling

Floating grease and oil may require skimming off, before measurement.

Condensation can form on the cell giving erroneous readings if the sample is too cold. Samples should warm up to close to room temperature before analysis. If it's still a problem, consider using the Nephelometer (in the WQ lab), which is connected to the air supply. When turned on, the air circulates through the sample chamber and prevents condensation from happening.

Light-absorbing materials cause a negative interference at high levels, while at low concentrations these particles may contribute to turbidity. Make note of any known matrices (ex: solvents).

The presence of **dissolved, color-causing substances** that absorb light may cause a negative interference. Instruments that have the four detectors and the "Ratio On" have the capability of either correcting for slight color interference or optically blanking out the color effect.

Chemicals & Reagents

Refer to LIMS [Summary Reports], [List of Certified Reference Materials], and [List of Qualified Supplier & Materials], for purchasing the required chemicals and solutions. Also review previous Laboratory Purchase Requisitions.

- Laboratory deionized water
- Silicone oil, always use Hach silicone oil which has the same refractive index as the glass sample cells.
- Primary Certified Formazin Standards for equipment calibration (Available in a set of <0.10, 20, 200, 1000 & 4000 NTU)
- Secondary Formazin Gel Standards and stray light measurement sample (each day of use and calibrated against the primary standards)
- Independent Primary Formazin Standard for CRM (mid-range)

Reagent Preparation Logs:

All forms, reagent logs located in *TurbidityForms.xlsx*

Obtain or download Certificates of Analysis (COA) for all purchased standards and CRMs. Print a LIMS label for placement on the certificate which is then scanned and saved as PDF file in the COA[6] folder.

Document the calibration of secondary standards on the reagent preparation log sheets and LIMS Chemicals and Standards.

Label reagents with Material Name, Concentration, Date Prepared, Expiry Date,

Analyst Initials, and Reagent Prep Log Reference Number or LIMS CRM Number.

Expiry Dates

Unless specified, all reagents in solid form have an expiry date of 5 years when unopened and 3 years from the date opened. Purchased reagents in liquid form have an expiry date of 3 years unopened and 12 months opened. All prepared reagents are considered "opened" on the date made and therefore never exceed 12 months. If the vendors' expiry date is less than these default dates, then use the vendors, i.e., always use the shortest date.

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Equipment & Supplies

Refer to LIMS Instrument Module and Equipment Logs.

Instruments

Hach 2100N with filter (compliant with USEPA 180.1)

Hach 2100Q (compliant with USEPA 180.1) – this portable Nephelometer (is a laboratory meter) that may be used when the Hach 2100N is being serviced. Follow the Vendor's Instrument Manual for calibration and use, and following this SOP for all other sections.

The Nephelometer located in the WQ laboratory is equipped with an air line. When the relative humidity is high and samples are cold, condensation can occur on the sample vials, and on the optical lens inside the instrument. This is noticeable by gradually increasing Turbidity readings and by visual inspection of the vials. When this occurs, turn the air flow on or bring the samples closer to room temperature.

Supplies & Glassware

- 30 mL sample cell, see Indexing a Sample Cell
- Oiling cloth
- Pipette(s)
- Class A volumetric flask or mixing cylinder, 50 mL
- 47 mm filter flask assembly with filter dome

Consumables

- Always keep a replacement bulb on hand.
- Filtration apparatus and glass fibre filter paper.
- 0.2 µm Teflon or glass fibre filter paper.

Equipment Manuals

Equipment Instruction Manuals[7] are listed in References, page 14.

The hard copy of the 2100 N Hach is located in the Water Quality laboratory in the magazine rack near the instrument.

Equipment Maintenance Logs

Document all non-routine maintenance, equipment problems arising from any error codes, and the bi-monthly calibrations in the corresponding LIMS instrument logs.

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Glassware Preparation

Inspect the sample cell for large or excessive scratching and discard as required.

Rinse the glassware with DI water prior to use.

Cleaning

1. Wash all new and dirty Turbidity vials with 50% Hydrochloric acid and rinse with copious amounts of water. Follow this procedure when monitoring ultra pure water.
2. After glassware has been used, rinse the sample cell (bottle) a minimum of three times using DI water.
3. Using a mild detergent and soft brush or wipe, remove the oil that was used to minimize scratches/interferences.
4. Store the sample cell(s) with DI water inside. (Also helps to identify the clean cell).
5. Store sample cells so that their sides will not scratch each other using foam blocks or with cardboard separators.

Disposable plastic containers are reused for routine wastewater samples. After each use, rinse the containers with hot water followed by copious amounts of DI water. Inspect for cleanliness and if any container appears dirty, discard and replace with a new container.

Quality Control Plan

Batch Creation

Set up a batch of samples and the Batch QC using the LIMS Batch Creation[5] process as outlined in the LIMS USER MANUAL. Each batch is assigned a unique number, which is recorded with each test assigned to the batch.

Method Quality Control

The following QC parameters are incorporated into every run and monitored by compliance to the control results in the "Enter Results"-"Enter Batch QC Data" function.

1. A stray light check
2. A secondary standard check (CalVer) – control chart
3. One independent Formazin standard (CRM) with every batch
4. One duplicate with every batch*
5. If any dilution is performed, run a sample blank using the same source water used for the dilutions

Record all QC data in QC Module of LIMS. Verify QC data against established upper and lower control limits. If a QC standard is out of control, treat as a non-conformance.

* If the duplicate has a turbidity over 40 NTU, perform the duplicate analysis on a different dilution. Since the range is linear, this should confirm that the reading is accurate. (Ex: If the sample is diluted 1/2 then do a duplicate with 1/4).

Acceptance Criteria

Calibration verification shall be within the established upper and lower control limits of three standard deviations ($\pm$ 3 %). These values shall be plotted on a control chart and are also entered in the LIMS.

Duplicate (& replicate) recovery shall be within the established upper and lower control limits of three standard deviations ($\pm$ 8.6%). These values shall also be entered into the LIMS QC.

Stray light shall be within $\pm$ 0.003 NTU of the recorded value in the LIMS. The reference value shall also be clearly marked on the stray light standard.

Sample blank shall be <0.1 NTU. This value shall be entered into the LIMS QC.

Non-Conformance and Corrective Action

If any of calibration verification, duplicate recovery control is outside of the control limits then run two primary calibration standards as a check. If one or more of the primary calibration standard(s) is out and the primary standard has not expired, recalibrate the instrument with the primary standards and calibrate the secondary standards.

If the primary calibration standards are acceptable, recalibrate the secondary standards. Make sure that the standards have not expired.

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Check the sample cell for large scratches or defects in the glass. Replace with new ones and index as necessary. Do not keep the scratched cells that are causing problems but dispose in the "broken glass" receptacles.

If none of the above recommended actions resolve the problem, then consult with the supervisor and/or quality assurance officer and;

- Carry out corrective action to resolve the problem and document (see Quality Manual for corrective action procedure).
- Maintain these non-conformance records for audit and review.

Proficiency Testing

The laboratory pursues accreditation and proficiency for Turbidity at both laboratory locations (2230 Main St. and the Water Treatment Plant), through the Canadian Association of Laboratory Accreditation.

Beginning in 2001 at the Analytical Services Laboratory and in 2011 at the Water Treatment Plant Laboratory, the laboratory participates in the CALA Proficiency Testing program for Turbidity. Turbidity is included in the C-04C Test Group; Turbidity in Water.

Test Procedure

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Warm up

Allow the instrument to warm up prior to Calibration or Sample Measurement.

Instrument warm-up with Ratio on is 30 minutes and 60 minutes with Ratio off.

Use the same pre-aligned sample cell for all sample measurements.

Since the Turbidimeter is used daily, the instrument is normally plugged into a timer which turns the instrument on in the morning and off at the end of the work shift. The timer is checked (and adjusted if necessary) once every two months on the same day as the Equipment Calibration with Primary Formazin Standards is conducted, and documented on the same worksheet.

Oiling

Oiling shall be performed at least once on all cells (sample & standards) each day in use, prior to using them.

1. Rinse the clean cell with a portion of sample/standard and discard.
2. Fill the sample cell to the mark.
3. Hold the sample cell by the cap and wipe with scratch free cloth to remove water spots and fingerprints.
4. Apply a thin bead of oil from the top to the bottom of the cell and spread uniformly with the oiling cloth.
5. Wipe the excess so that the glass appears dry.

Indexing a single sample cell

Indexing is important with low turbidity water, because it minimizes the background interferences that come from scratches or inconsistency in the actual glass.

Always index the sample cells following the equipment calibration with primary standards, as well as any new sample cells before they are put into use.

1. Fill a clean sample cell with high quality water and cap.
2. Prepare the sample cell by oiling.
3. Insert the sample cell in the instrument, line up the mark and close the lid. Press [Enter] and record the reading.
4. Lift the cover, rotate the cell 1/8 turn clockwise, close the lid, press [Enter] and record the reading.
5. Continue this procedure until the smallest NTU reading is obtained.
6. Place a mark on the sample cell marking band, adjacent to the index mark of the instrument. (Point or arrow on the plastic housing.)
7. Use this mark to align the sample cell for all measurements.

Indexing several sample cells

1. Index the first sample cell as above.
2. Fill the second sample cell with high quality water. Insert and close the lid. If the turbidity reading is within 0.01 NTU of the first indexed cell then add a permanent orientation mark to the cell. If not, rotate 1/8 of a turn and note the reading.
3. Continue until the turbidity reading is within 0.01 NTU. Any sample cell that exceeds 0.01 in all positions cannot be used for turbidity measurement.
4. Continue with the other sample cells, while always comparing to the first indexed cell.

Equipment Calibration with Primary Formazin Standards (StablCal)

Calibration is done every 2 months or as required.

Remove the wavelength filter (required per EPA standard) and clean as required using a lint-free non-scratching cloth. Put back in place with the "Front" label towards the front, closest to you.

1. ***Never mix*** the <0.1 NTU standard. For all other standards, if they have not been used for some time, shake vigorously for 2-3 minutes then let the standards sit undisturbed for 5 minutes to remove air bubbles. Otherwise, invert 10 times to mix. There should be no solids settled on the bottom of the vial.
2. Fill a clean sample cell with high quality water, cap, and oil.
3. Place in the sample holder and close the cover.
4. Press the [CAL] key, the SO light will go on and the NTU value from the last calibration will be displayed.
5. Press [ENTER], the instrument counts down from 60 to 0 and then makes a measurement. This result is stored in the instrument and is used to compensate for the turbidity of the dilution water or "blank".
6. The meter will advance to the next standard, the S1 light is on, and the display reads the next expected NTU, ex: 20.00. Remove the standard from the compartment.
7. Mix, oil and insert into the next standard, 20 NTU into the sample holder, align and close the cover.

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8. Press [ENTER] and continue as in step 4 with the 200, 1000, and 4000 NTU standards.
9. After the 4000 NTU is completed, the instrument returns to the dilution water standard, S0 light will be on, press the CAL key to store the new calibration curve.
10. Document the calibration in the Equipment Log and corresponding LIMS Instrument log. Label the instrument with the Date of Last Calibration and Date of Next Calibration (due date) and analyst who performed it.
11. Index the sample cell(s).
12. Proceed to Calibration of Secondary Standards.

If any problems are encountered or the calibration is not linear, an error message will appear. Review the instrument manual for diagnosing problems.

Calibration of Secondary Standards (Gelex StablCal®)

Secondary standards are recalibrated following every calibration or as required.

1. Verify that the instrument is warmed up and set to Ratio On, Signal Averaging and Automatic Ranging. Starting with the Stray Light standard, oil, insert and align in the sample holder. Close the cover and wait for a stable reading.
2. Record the reading in the Equipment and Secondary Calibration records and label the top of the bottle with the new reading.
3. Remove from the sample holder and repeat with the 1-2 NTU, 10-20 NTU, 100-200 NTU, and 200-4000 NTU.
4. Use the stray light and a second standard (calibration verification) each day that the instrument is in use. Record the readings in the TURBIDITY QC Records.
5. Index Sample cells after every calibration to determine if the cells are still performing optimally.

Removing Air Bubbles

Degassing is recommended to remove air and other entrained gases prior to sample measurement. Use method A, B or a combination of both methods when the interfering air bubbles are visible.

A. Applying a vacuum.

Fill the sample cell and apply vacuum with a clean, oil-free hand operated pump fitted with a rubber stopper. A large syringe fitted with a # 1 rubber stopper can also be used. Allow the sample to sit at atmospheric pressure for a minute before capping and sample measurement.

B Ultrasonic bath.

Excess application of ultrasonic waves may alter the particle size.

Do not exceed the recommended time as predetermined using the method outlined in the equipment manual. Record the maximum time for future use.

Fill the sample cell, leave uncapped, and immerse ½ to 2/3 in an ultrasonic bath until the visible air particles are removed or the maximum time is reached, whichever occurs first.

For all other samples, bring the sample containers to the instrument.

Sample Measurement

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1. Allow the instrument to warm up and set to Ratio On, Signal Averaging and Automatic Ranging.
2. Prepare the stray light, calibration verification, CRM and sample cells by Oiling. This step may be omitted only if the cells have already been oiled that day,
3. Run the stray light, Calibration Verification Standard and the CRM and record in the TURBIDITY QC Records. If the calibration is within the acceptable established control limits then proceed with the sample.
4. For wastewater effluents, industrial or hauled wastes; examine the sample and remove any "floatable" solids and decant any grease.
5. Select the most appropriate option of filling the sample cell;

Option A (Samples in containers)

Ensure that the cap is tightly closed, and then invert the container several times. Immediately open the lid and fill the sample vial/cell to the indicated mark. DO NOT shake the sample bottles vigorously as this will introduce air bubbles and give false readings.

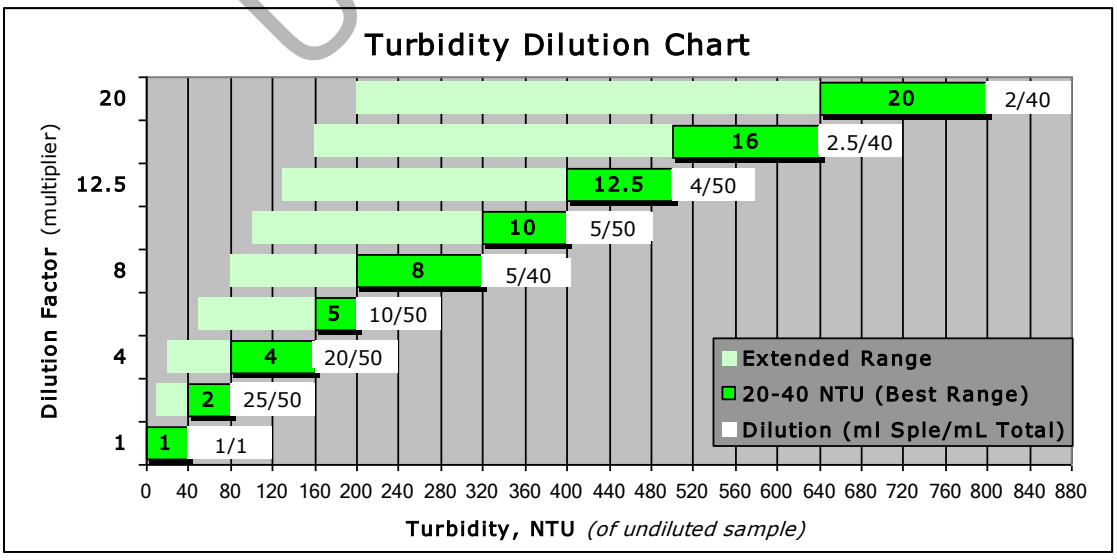
Option B (Wastewater aliquots, sample cups without lids)

Gently and thoroughly mix the sample by creating a vortex using a Teflon or Glass stir stick then immediately pore and fill the sample vial/cell to the indicated mark and cap.

i. Wipe, and then mix again by inverting the vial a few times. Insert and align in the sample holder.

ii. Close the cover and wait for a stable reading. If the sample is cold, condensation on the sample cell caused by the heat of the lamp may occur. This is noticeable by gradual increase in the sample turbidity. If this cannot be avoided, the lower reading is recorded.

iii. For samples with turbidities greater than 40 NTU, dilute the sample using DI water until it is within range. Use the minimum dilution required to bring the sample within range aiming for a mid to high range Turbidity reading. The following table is based on diluting the sample to read in the 20 to 40 NTU range. Extrapolate the initial measurement from the x-axis up to the corresponding dilution, (reddish horizontal bars), to determine the dilution required. Record the dilution, the turbidity measurement, and calculate and record the turbidity based on the dilution factor. Run a sample blank using the same source water used for the dilution.



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Data Analysis & Calculations

When there are no dilutions, Turbidity readings, NTU are read directly from the instrument.

Dilutions

Turbidity $_{reported}$ = Turbidity $_{reading}$

Calculate diluted samples back to their original concentration.

Sample NTU = Turbidity $_{reading}$ NTU X mL final volume
Sample volume mL

Calculation of Duplicates or Repeats

%Difference = (Duplicate sple – Initial sple) x 100/ Initial sple

Calculation of %Recovery

$\%Recovery_{QAstd}$ = ($Result_{QAstd}$/Certified Value*) x 100

where QAstd is a HRM, CRM, Calibration Verification Standards or Calibration Check Standard

*as listed on the Certificate of Analysis or as prepared (expected) concentration

Safety

Lab coat and safety glasses/goggles must be worn in the laboratory at all times.

Wear gloves when handling corrosive chemicals, wastewater, industrial wastes, and unknown sample matrices.

Refer to each chemical MSDS for detailed hazards and handling instructions, available on the City of Winnipeg's intranet site "Wellness" page[8].

Sewage samples contain pathogenic organisms. Wear gloves, eliminate contact above the chest while working, and thoroughly wash hands with a disinfectant soap after handling.

Refer to Environmental Standards Division, Health and Safety Manual[9], and applicable safe work procedures in the SafeWorkProcedures manual[10].

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Revision History

Version No.	Issue Date	Author/Reviewers
4.2*		G. Levesque/ J. Jones
5.0	December 18, 2013	G. Levesque/ H.Demchenko
5.1	October 24, 2014	J. Jones/G. Levesque

*Revision details are documented in these historical versions.

Version 5.0

Introduction and Scope, updated precision and uncertainty ..... p 4
Reagent Preparation Logs, added expiry date information ..... p 6
Method Quality Control, run a sample blank if a dilution is performed ..... p 8
Acceptance Criteria, sample blank shall be <0.1 NTU ..... p 8
Oiling and Sample Measurement, perform oiling daily on all cells in use ..... p 9, 11
Document Control, procedure for Certificates of Analysis added ..... p 14

Current Version 5.1

Hyperlinks to external documents removed from the main body and replaced with endnote references.

Interferences, Condensation; at ASB lab, use instrument connected to air supply ..... p 5
Equipment, Maintenance, document non-routine and Bimonthly checks in LIMS Instrument ..... p 7
Reagents, Reagent Logs, download/scan the COA for all CRMs ..... p 6
Test Procedure, Oiling, Must be performed on all cells in use and each day in use. ..... p 9
Revision History, includes a table, for better historical documentation (going forward), it's much easier to note when a version number might be skipped and how often the revisions occur. ..... p 13
Endnotes (file and folder locations), new section listing the location of all referenced documents. .. p 15

Next Review[11]**;** No Later than October 31, 2015.

Use the following only if there are no changes required at the next review or there are minor handwritten amendments suitable for continued use, i.e. the SOP does not have to be formally recompiled and distributed.

Annual Review includes verification/ensuring that the laboratory has the most current version of all the referenced methods and manuals and that obsolete documents, manuals, etc. are removed and documented as required.

Sign the following only if there are no significant changes required at the next review.

Reviewed By: _____ Review Date: _____

Next Revision Date: _____

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Appendices

Tab 1: Certificates of Analysis

Tab 2: Method Validation

Tab 3: Quality Control Tables

Reagent Logs and Calibrations

Tab 4: Quality Control Charts

Tab 5: Equipment Maintenance and Operation Logs

Document Control

After completion, Control Charts, Reagent Logs, and Equipment Maintenance logs are placed into the appendices of the master document binder. After each calendar year, the hard copy charts and logs are turned into electronic format, as PDF files. These are filed in the Turbidity Method, QC RECORDS (Historical PDF) folder and hard copies are destroyed in accordance with the documented policy of the Quality Manual.

Certificates of Analysis: verify that the PDF version is available from the COA folder. Scan and file any missing documents, then destroy the paper copy as per the Quality Manual policy.

References

Equipment Instruction Manuals

Hach Model 2100N Turbidimeter, Instrument Manual, HachModel2100AN.pdf

2100N Laboratory Turbidimeter, QuickReference_2100N.pdf

Manual Change Notice 2100 Series Laboratory Turbidimeters (Operation Manual), ManualChangeNotice_2100series.pdf

Reference Texts

2130A Turbidity & 2130 B Nephelometric Method, Standard Methods for the Examination of Water and Wastewater

Turbidity Science, Technical Information Series-Booklet No. 11, Michael J. Sadar

EPA 180.1 Turbidity (Nephelometric)

Endnotes (file and folder locations)

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[1] All forms, worksheets, reagent logs located in
N:\Environmental Standards\Methods\Turbidity (SOP 15)\FORMS

[2] Control Charts are printed from "ChartGenerator.xlsm" workbook in;
N:\Environmental Standards\Analytical Services\Charts

[3] Standard Methods for the Examination of Water and Wastewater, download from on-line account (http://www.standardmethods.org), as PDF in;
N:\Environmental Standards\Analytical Services\Standard Methods

[4] Method Validation Data is located in;
N:\Environmental Standards\Methods\Turbidity (SOP 15)\METHOD-VALIDATION

[5] All Standard Operating Procedure; SOP-17 Sampling, SOP-51 Glassware, SOP-50 LIMS User Manual in; N:\Environmental Standards\Analytical Services\SOP (PDFs)

[6] Certificates of Analysis are downloaded or scanned and filed in the corresponding folder and named according to its Chemical ID No. in;
N:\Environmental Standards\Analytical Services\Certificate Of Analysis(CRM,Stds)

[7] Equipment Operation Manuals are available from the following two locations;
N:\Environmental Standards\Methods\Turbidity (SOP 15)\MANUALS
N:\Environmental Standards\Analytical Services\Instrument & Software\

[8] Access MSDS from the City of Winnipeg, intranet Wellness webpage at;
http://citynet/intrahom/toc/wellness.stm

[9] Safety Manual located in;
N:\Environmental Standards\Safety\SafetyManual

[10] Safe Work Procedures in;
N:\Environmental Standards\Safety\Safe Work Procedures\Safe Work Procedures

[11] Perform the review as described in the Method Validation, Method Review section of the Quality Assurance Manual (SOP 16, QAM) in:
N:\Environmental Standards\Methods\Quality Manual (SOP 16)

The official MS Word document of this SOP is maintained in a secure controlled location;
N:\Environmental Standards\Quality Assurance\SourceDocs\Current Word\SOP-15_Turbidity_v5-1.docx

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